

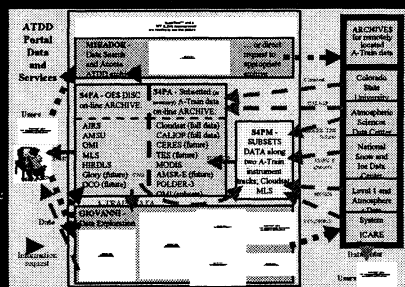
# A-Train Data Search and Visualization to Facilitate Multi-Instrument Cloud Studies

Steven Kempler\*, Peter Smith\*, Andrey Savchenko\*, Gregory Leptoukh\*, Graeme Stephens\*, David Winker\*

NASA Goddard Space Flight Center, \*Colorado State University, \*NASA Langley Research Center, \*NASA Goddard Space Flight Center, \*SES42

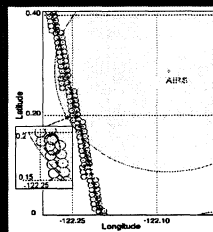
## 1. Links to all A-Train datasets from one portal:

Full and subsetted datasets archived locally can be downloaded via ftp. For datasets not archived locally, the user is linked to the appropriate archive.



## 2. Co-registration of datasets with different formats, resolutions, scales:

Red circles represent the median MODIS pixels in the collocated subset, i.e. frame no. while greens are frame #5. If the narrow-swath subset is taken. The subset MODIS pixels depicted here are of 1.1-km size: given the farthest separation of MODIS nadir and CloudSat at the Equator, the collocated subset here is about 200 pixels from the nadir. One actual CloudSat FOV is shown to scale in the inset for comparison. (Savchenko)



## 3. Quick dynamic visualization and exploration of data from different instruments together to determine the desirability of the data prior to accessing potentially undesirable data

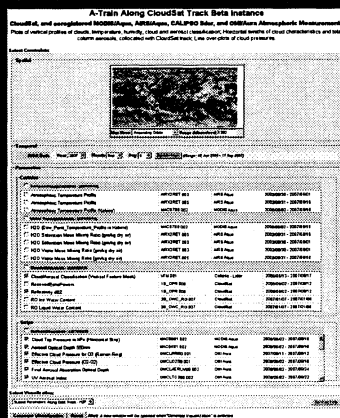
### Giovanni Data Exploration Tool:

Select day of interest

Select Segment on the A-Train orbit

Select Parameters

Select Generate Visualization



## Currently Accessible Products

### Vertical Profiles (Curtain Plots)

- Cloud Products -
  - CALIPSO - Cloud/Aerosol Classification
  - Cloudsat - Reflectivity dBZ
  - Cloudsat - RO Ice Water Content (new)
  - Cloudsat - RO Ice Water Path (new)
  - Cloudsat - RO Liquid Water Content (new)
  - Cloudsat - RO Liquid Water Path (new)
- Temperature Products -
  - MODIS - Atmospheric Temperature Profile
  - AIRS - Atmospheric Temperature Profile
- Water Vapor Products -
  - MODIS - H<sub>2</sub>O
  - (Dew Point Temperature, Profile)
  - AIRS - H<sub>2</sub>O Saturation Mass Mixing Ratio
  - AIRS - H<sub>2</sub>O Vapor Mass Mixing Ratio

### Horizontal Strips (±100 km from Cloudsat path) or line plot overlays upon vertical profile

- OMI - Effective Cloud Pressure for O<sub>3</sub> (RR)
- OMI - Effective Cloud Pressure (O<sub>2</sub>-O<sub>2</sub>)
- OMI - Final Aerosol Absorption Optical Depth (new)
- OMI - UV Aerosol Index (new)
- MODIS - Aerosol Optical Depth 550nm
- MODIS - Aerosol Fine Mode Fraction 550nm
- MODIS - Cloud Optical Thickness
- MODIS - Cloud Top Pressure
- MODIS - Cloud Top Temperature
- AIRS - Cloud Top Pressure
- AIRS - Cloud Top Temperature
- AIRS - Total Cloud Liquid Water

## Abstract

Now that the A-Train suite of datasets have become more mature, new and innovative science utilizing the various products has become more reliable and challenging. To perform multi-satellite research with A-Train data originating from heterogeneous missions, scientists must access, subset, visualize, and analyze user specified datasets, in ways unique to the dataset. Then, the datasets need to be co-registered, and maybe merged.

The A-Train Data Depot (ATDD) has been developed to save each scientist the effort and expense of developing these functions individually.

The ATDD, operational for over a year

successfully serves co-registered data, as spatially and temporally specified by the researcher, from the Cloudsat, CALIOP, AIRS, MODIS, OMI, and MLS data instruments.

Specifically, The ATDD provides the following cost saving services to the A-Train data researcher:

1. Links to all A-Train datasets from one portal
2. Co-registration of datasets with different formats, resolutions, scales
3. Quick visualization and exploration of data from different instruments together to determine the desirability of the data prior to accessing potentially undesirable data
4. Analysis and inter-comparison of data from different instruments
5. Dynamic specification and acquisition of subsetted MODIS, OMI, and AIRS data removing need for researcher to down load large amounts of data
6. Easy downloading of co-registered data: Connects to distributed datasets, accesses and reads different datasets, co-registers the heterogeneous data resolutions, and visualizes the data together.

### More to come...

- Polder data operational
- AMSR-E, TFS, IIRDLIS data
- NO<sub>2</sub>, CO<sub>2</sub>, other products
- User Selected Ranges
- MLS data along the Cloudsat track
- UV aerosol index background on the orbit picker

Figure 1: A-Train Data Depot (ATDD) architecture. The ATDD is a central hub that provides access to A-Train data from various instruments and archives. It includes a portal for data search and visualization, and a depot for data storage and distribution.

## Studying Clouds...

### Vertical Profiles (curtain plots) & Horizontal Strips ±100 km from Cloudsat/CALIPSO nadir

## 4. Analysis and inter-comparison of data from different instruments

As of now, the ATDD provides data inter-comparison through visualization and access, using the GIOVANNI data exploration tool, for:

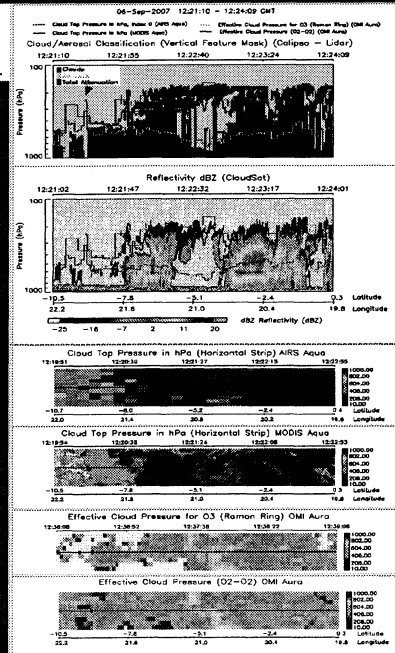
### Vertical Profiles of 8 Cloudsat, CALIOP, MODIS, and AIRS products

- Cloud and aerosol
- Atmospheric temperature
- Water vapor profile parameters

### Horizontal Strips (±100 km from Cloudsat nadir) of 10 MODIS, AIRS, and OMI products

- Cloud pressure
- Water vapor
- Cloud optical thickness
- Aerosol

### Overlay line plots of OMI, POLDER, MODIS, and AIRS 2-D cloud pressure data on the vertical profiles



## A-Train Data Depot in a nutshell

http://atdd.gsfc.nasa.gov/atdd/

Purpose: Saves researchers great amounts of effort by using ATDD services

Sensors: Cloudsat, CALIOP, AIRS, OMI, MLS, and MODIS

Areas of Study: Cloud, aerosol, atmospheric temperature, water vapor parameters, atmospheric composition

Services: Dynamically subset, visualize, co-register, and access multi-sensor A-Train data

Output: HDF, PNG, KMZ (prototype)

2007 Metrics (thus far)

• Number of Products Provided: 4,917,916

• Number of Product Types Available: 38

• Volume of Data Distributed: 8079 GB

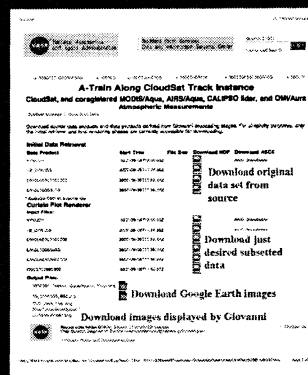
• Volume of Data Available: ~16 TB



## 6. Easy downloading of co-registered data

Giovanni visual outputs include vertical profiles, horizontal strips, and line overlays on vertical profiles

User accessible data files are available for the data visualized, the original granule containing the data visualized, a file of the visualized image, and recently prototyped, a google earth image.



## 5. Dynamically specifying and acquiring subsetted data removes need for researcher to down load large amounts of data

An essential service provided by the ATDD is the subsetting and archival of:

- Large, remotely located datasets (MODIS, AMSR-E, POLDER (being prototyped), CERES (future)) ~100 km and ~5 km along the Cloudsat track.
- Locally archived dataset, OMI, in a similar fashion.
- The pixel of data that represents lines plotted on the vertical profiles

AIRS data is also subsetted, on the fly, but not archived. AIRS subsets are easily reproducible

Simple data reduction as a result of subsetting.

Example of data volume reduction	Subset around Cloudsat nadir	Initial Volume (MB per Granule)	Subsetted Volume (MB per Granule)	% of Original Data Volume
MODIS (22 channels - subset centered on each Cloudsat at profile)	~5 km	69.7	0.81	0.7 %
MODIS (22 channels - subset centered on each Cloudsat at profile)	~100 km	69.7	7.4	11 %

## PROTOTYPE: Exploring A-Train Data in 3D

You select, You visualize. You download MODIS Cloud Top Temperature line plot on Cloudsat Reflectivity profile. Cloudsat Reflectivity profile on MODIS Daily Cloud Top Temperature Horizontal Surface

